

MEMORANDUM

October 27, 2004

FOR: FCRPS Remand File

FROM: Richard Domingue, NOAA Hydrologist

SUBJECT: Method for Calculating Seasonal Average Flows for Remand BiOp

Purpose: To define the seasonal average flows for alternative operating scenarios for the purpose of modeling differences in fish survival based on those flow differences. Two alternatives were considered: the 2000 BiOp base case (proposed action) and the Reference Operation (designed to minimize discretionary system-induced fish mortality). The objective was to define flow differences during the juvenile salmon and steelhead outmigration seasons and the chum spawning season.

Model Used: HYDSIM, All HYDSIM model runs were conducted by the Bonneville Power Administration (Roger Schwiewe and Jennie Tran). Data aggregation and manipulation were performed using Excel.

Methods:

Step 1

The period of record for the input files to the HYDSIM model and the outputs of simulated operations cover the period August 1929 through July 1978. It was therefore necessary to identify years with similar hydrologic conditions to the years 1994 through 2003, which were being used to estimate fish survival differences between operations scenarios. The first step in the process for determining the HYDSIM simulated seasonal average flows for the reference years 1994 through 2003 was to identify three years with April-through-August runoff volumes that were similar to the year of interest. This was done by collecting the actual April-through-August runoff volumes for the years of interest and identifying the years in the HYDSIM record period with the nearest runoff volume to the subject year, as well as the next higher and next lower years. This comparison was conducted using data from Crook (1993) that have been modified to simulate hydrologic conditions that would exist if the 1990 level of irrigation had been in place throughout the period and flows were unaffected by storage and release patterns of dams throughout the Columbia basin. Spreadsheets displaying these surrogate years follow as Table 1 and Table 2.

Step 2

A series of HYDSIM model runs was conducted and analyzed for both the proposed action and the reference operation. Only the final models are discussed herein. Details of the constraints placed on each of these runs are available elsewhere in the record. HYDSIM output files including detailed outputs for each project in the system are also available elsewhere in the record. For this analysis, discharge data from Lower Granite, McNary, and Bonneville dams

were chosen to represent conditions in the lower Snake River, the lower Columbia River, and downstream from Bonneville Dam, respectively. The periods of interest for juvenile fish passage are:

- Spring
 - at Lower Granite: April 3 - June 20 (79 days)
 - at McNary: April 10 - June 30 (82 days)
- Summer
 - at Lower Granite: June 21 - Sept. 30 (102 days)
 - at McNary: July 1 - Sept. 30 (92 days)

Stream flow conditions downstream from Bonneville Dam are pertinent to the survival of chum salmon from spawning through incubation, emergence, and outmigration (November 1 through April 15 [166-167 days]). Data from the two operating alternatives for Lower Granite and McNary dams for the spring and summer period for the surrogate years were collated into individual spreadsheets. Tables 4, 5, and 6 provide simulated flow conditions under the proposed action for Lower Granite Dam, McNary Dam, and Bonneville Dam, respectively. Tables 6, 7, and 8 provide the same information for the reference operation.

The seasonal averages for the summer period include data from August and September for the subsequent operating year (August-July), because the HYDSIM operating year ends in July, and the migration period extends through the end of September. Hence, if the 1940 operating year is chosen as a surrogate, data from the HYDSIM run for August 1941 become part of the summer average of interest.

Step 3

Streamflow depletions caused by USBR's irrigation operations are a part of the proposed action. Because the hydrologic record used by the HYDSIM model included the 1990 level of irrigation depletions, including depletions caused by USBR project operations, it was necessary to identify those depletions caused by USBR project operations and eliminate them from the reference operation.

In the case of the Columbia Basin Project, the HYDSIM model incorporates the operation of the diversion which occurs at Grand Coulee Dam. Thus, eliminating the effects of the Columbia Basin Project from the reference operation was simply a matter of setting the diversion rate to zero and reducing estimated return flows to zero. The Columbia Basin Project is the largest irrigation project in the basin and diverts up to 2.2 Maf annually with very low return flows.

Eliminating the effects of USBR-caused depletions in tributary streams is less direct. The HYDSIM model automatically augments flows at each tributary mouth in accordance with a historical record for that tributary. In the current model, those tributary flows were derived from a study that estimated the historical hydrologic record if the 1990 level of water development had been imposed at the beginning of the record. To eliminate the depletive effects of USBR operations in each tributary, USBR estimated the average streamflow depletions for each month

(Table 3). Then, for the reference operation, NOAA Fisheries added the water that was lost to USBR tributary depletions back to the Columbia River at the appropriate locations (see Tables 7,8, and9).

Step 4

Data from the HYDSIM simulation of operations under the proposed action (consistent with 2000 BiOp) and the reference operation were compared and the flow differences displayed. Tables 10, 11, and 12 provide dam-specific summaries and comparisons of the seasonal averages under the two operating scenarios. These are the data used to drive portions of the SIMPAS model in estimating the survival gap between the two alternative operating scenarios.

Table 1. 2000 BiOp Remand Hydrologic Analysis – Snake River Runoff Comparison. 1994-2003. Observed April-July Runoff Compared to Equivalent Historical Runoff Years in 1928-78 Record.

2000 BiOp Study Year	Observed Apr-Jul Runoff Volume, in Maf	Historical		3-year average Apr-Jul Runoff Volume, in Maf
		Historical Runoff Years	Apr-Jul Runoff Volume, in Maf	
1994	11.3	1934	12.52	
		1973	12.21	11.83
		1931	10.77	
1995	21.0	1946	22.01	
		1933	21.00	21.30
		1959	20.93	
1996	28.4	1975	29.26	
		1976	28.48	28.49
		1957	27.72	
1997	33.5	1974	35.68	
		1971	34.59	33.94
		1943	31.56	
1998	23.7	1951	24.11	
		1949	23.78	23.83
		1953	23.61	
1999	25.8	1950	27.20	
		1964	26.10	25.92
		1969	24.47	
2000	17.2	1942	18.49	
		1961	17.05	17.13
		1940	15.86	
2001	10.3	1973	12.21	
		1931	10.77	10.54
		1977	8.64	
2002	19.0	1955	19.93	
		1960	18.97	19.23
		1963	18.78	
2003	16.7	1961	17.05	
		1940	15.86	16.10
		1968	15.40	
10-yr. mean	20.7			20.8
61-yr. mean	21.39			

Table 2. 2000 BiOp Remand Hydrologic Analysis – Columbia River Runoff Comparison. 1994-2003.

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Observed April-August Runoff Compared to Equivalent Historical Runoff Years in 1928-78 Record.

2000 BiOp Study Year	Observed Apr-Aug Runoff Volume, in Maf	Historical Runoff Years	Historic Apr-Aug Runoff Volume, in Maf	3-year Average Apr-Aug Runoff Volume, in Maf
1994	67.2	1940	70.82	
		1937	67.10	67.91
		1930	65.81	
1995	86.1	1962	90.49	
		1934	87.89	87.61
		1936	84.44	
1996	111.0	1950	114.20	
		1954	111.90	111.70
		1965	109.00	
1997	133.1	1974	134.60	
		1972	129.60	130.00
		1956	125.80	
1998	90.1	1949	91.15	
		1962	90.49	89.84
		1934	87.89	
1999	110.3	1954	111.90	
		1965	109.00	109.70
		1943	108.20	
2000	84.2	1934	87.89	
		1936	84.44	85.32
		1970	83.63	
2001	52.8	1931	59.32	
		1944	55.97	54.96
		1977	49.58	
2002	93.8	1947	94.17	
		1955	93.96	93.19
		1960	91.43	
2003	73.8	1945	75.68	
		1939	74.93	73.81
		1940	70.82	
10-yr. mean	90.2			90.4
61-yr. mean	91.91			

Project	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Chief Joseph Dam Project	2	0	0	0	0	0	10	64	138	190	112	22
Σ Effects at Priest Rapids	2	0	0	0	0	0	10	64	138	190	112	22
Lewiston Orchard	4	2	0	1	3	14	40	27	17	3	5	4
Σ Effects at Lower Granite	4	2	0	1	3	14	40	27	17	3	5	4
Yakima ²	0	0	0	0	0	0	0	-298	389	-27	0	0
Umatilla Phase II pump exchange	62	0	0	0	0	0	2	8	47	137	146	96
Σ Effects at McNary	68	2	0	1	3	14	52	-199	591	303	263	122
Umatilla Phase I Pump Exchange	32	0	0	0	0	-5	-10	-2	52	19	138	50
Umatilla River	-196	5	186	244	314	-91	27	-51	-129	26	-36	-135
Deshutes	-167	-7	31	100	98	453	163	13	-104	-84	-138	-136
The Dalles	4	0	0	0	0	0	7	27	37	47	38	22
Σ Effects at Bonneville	-259	0	217	345	415	371	239	-212	447	311	165	-77

¹ Negative values indicate instances where historical project operation resulted in increased flows to the Columbia River

² Yakima Numbers are base on a year with “average” water supply. Fifty percent of the years there would be no flood control operations so no effects.

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Table 4. Lower Granite Period average discharge for the Proposed Action.

Data from: FRIII_03Biop2004.XLS 10/21/04. Data presented is water year data (e.g., AUG1(WY1934)=AUG1(CY1935))

BiOp Study Year	HYDSIM Surrogate years	Total discharge in cfs													
		AUG1	AUG2	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR1	APR2	MAY	JUN	JUL
1994	1934	20954	14785	23950	22178	21905	44104	53837	40292	48568	89158	96646	59731	29314	29762
	1973	25073	18647	28264	33095	24099	33896	35980	31696	34522	38706	42039	68286	51406	37298
	1931	20361	14434	23597	19786	15550	12259	20501	21102	29654	54590	41502	62893	33559	28652
	average	22129	15955	25270	25020	20518	30086	36773	31030	37581	60818	60062	63637	38093	31904
1995	1946	34218	22318	32104	27169	20815	33785	40405	41148	64880	95649	125995	112640	76651	46186
	1933	33245	21260	28504	21976	19810	17828	23816	24571	33366	49935	86212	79729	138242	48359
	1959	35950	24389	38080	25583	26142	38193	55087	50346	49390	74499	64978	86043	111769	49317
	average	34471	22656	32896	24909	22256	29935	39769	38688	49212	73361	92395	92804	108887	47954
1996	1975	43481	43975	39345	32897	18614	27734	33020	44560	62292	62307	81666	110761	166031	90744
	1976	43200	41107	38592	41844	28251	60064	54809	50949	64360	122254	106768	150903	116831	54560
	1957	33658	22968	30717	27053	21906	34568	29528	44103	65991	105321	104031	172659	118860	48098
	average	40113	36017	36218	33931	22924	40789	39119	46537	64214	96627	97488	144774	133907	64467
1997	1974	42837	38942	36480	28973	33008	45550	83194	73192	91841	112804	141633	143208	194672	69888
	1971	42698	37716	42782	34417	27471	39291	69506	96147	75706	104679	113731	175645	166851	69907
	1943	42046	36398	34854	23521	19307	30741	45805	60502	77381	149826	163113	118254	131032	78908
	average	42527	37685	38039	28970	26595	38527	66168	76614	81643	122436	139492	145702	164185	72901
1998	1951	38670	27631	30119	38306	32464	46077	49224	72879	61359	106919	106725	113608	90799	53533
	1949	30387	21040	28228	25324	19655	23123	28165	41351	74239	96905	112320	149935	77966	41456
	1953	38886	35422	33460	23687	16229	20759	44760	53559	46134	48221	83604	87039	144733	61135
	average	35981	28031	30602	29106	22783	29986	40716	55930	60577	84015	100883	116861	104499	52041
1999	1950	41747	36032	37101	25379	20120	25363	32155	52232	80358	105350	100777	100655	138051	64098
	1964	40132	36352	36950	24872	19198	19576	27076	28052	37667	89841	79511	100111	164201	53425
	1969	32292	23486	29652	32263	30420	33266	63884	51542	60909	105208	117641	142453	83016	46769
	average	36571	30061	32666	26772	21401	25346	41038	43942	59645	100133	99310	114406	128423	54764
2000	1942	32805	21358	28009	27169	25045	38751	33463	32049	32602	73560	90076	85331	89218	50479
	1961	26261	18293	28283	23396	19597	18767	22146	48793	46257	56212	69837	83487	90466	36935
	1940	23076	16211	27546	21558	15328	17142	24798	35760	55192	76369	79402	90568	53039	34770
	average	27381	18621	27946	24041	19990	24887	26802	38867	44684	68714	79772	86462	77574	40728

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Table 4. Lower Granite Period average discharge for the Proposed Action (continued)

BiOp Study Year	HYDSIM Surrogate years	Total discharge in cfs													
		AUG1	AUG2	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR1	APR2	MAY	JUN	JUL
2001	1973	25073	18647	28264	33095	24099	33896	35980	31696	34522	38706	42039	68286	51406	37298
	1931	20361	14434	23597	19786	15550	12259	20501	21102	29654	54590	41502	62893	33559	28652
	1977	21725	17941	27029	30463	18251	26148	25208	26371	22738	30228	38187	37776	33752	26174
	average	22386	17007	26297	27781	19300	24101	27230	26390	28971	41175	40576	56318	39572	30708
2002	1955	36177	32452	31038	23513	17460	21182	25900	26729	23963	50068	69302	85896	114046	50473
	1960	35950	24389	38080	41883	29794	31045	36375	38980	57398	99488	84618	80952	93821	42559
	1963	35446	23665	31393	34317	25638	38426	34363	63403	38273	50601	51694	97172	103495	50469
	average	35858	26835	33504	33238	24297	30218	32213	43037	39878	66719	68538	88007	103787	47834
2003	1961	26261	18293	28283	23396	19597	18767	22146	48793	46257	56212	69837	83487	90466	36935
	1940	23076	16211	27546	21558	15328	17142	24798	35760	55192	76369	79402	90568	53039	34770
	1968	35681	30501	29308	27174	25100	30681	32223	59167	46501	41284	38575	71127	91469	43754
	average	28339	21668	28379	24043	20008	22197	26389	47907	49317	57955	62605	81727	78325	38486
Period Averages		32575.6	25453.6	31181.7	27781.1	22007.2	29607.2	37621.7	44894.2	51572.2	77195.3	84112.1	99069.8	97725.2	48179

Lower Granite Avg Seasonal Discharge in cfs

BiOp Study year	Spring Rounded April 3-June 20	Spring April 3-June 20	Summer June 21 - Sept 30	Summer Rounded June 21 - Sept 30
1994	56030	56027	26620	26620
1995	93600	93599	43548	43550
1996	125120	125122	54922	54920
1997	145370	145374	61606	61610
1998	105290	105292	44751	44750
1999	112740	112740	48935	48940
2000	80020	80021	35150	35150
2001	53990	53991	26907	26910
2002	84800	84802	44050	44050
2003	73320	73323	35289	35290
Avg	93030			42180

Table 5. McNary period average discharge under the Proposed Action. Data from BPA HYDROSIM Model run: FRIII_03Biop2004.XLS. 10/21/2004.

		Total discharge in cfs													
BiOp Study year	HYDSIM Surrogate years	AUG1	AUG2	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR1	APR2	MAY	JUN	JUL
1994	1937	143646	108461	91508	100803	118057	119271	102990	99584	106918	116726	131034	137798	173324	160663
	1940	134684	111012	93196	103671	117690	115317	140558	113751	160483	161701	194842	209855	191642	148324
	1930	150463	115247	91590	100202	118063	116675	96728	120940	107885	120577	121035	129835	166900	149787
	average	142931	111573	92098	101559	117937	117088	113425	111425	125095	133001	148970	159163	177289	152925
1995	1934	137656	115761	95595	120423	161390	231081	300465	240584	179966	280961	293083	272537	162627	186034
	1962	178400	134937	95007	101990	113604	113432	169643	117810	109436	250471	271037	247015	235271	197428
	1936	156408	120389	93816	98629	117341	119307	107927	96316	113364	135082	214737	322656	213045	159180
	average	157488	123696	94806	107014	130778	154607	192678	151570	134255	222171	259619	280736	203648	180881
1996	1954	230840	201370	161930	106653	121438	146643	172181	192261	152800	199639	218224	318359	371064	265034
	1950	200000	163922	109302	102702	114206	118679	166274	201142	227552	233154	257236	287194	413075	270792
	1965	200000	164725	106926	125344	124411	200265	271505	235434	194165	206007	305909	332524	318397	212064
	average	210280	176672	126053	111566	120018	155196	203320	209612	191506	212933	260456	312692	367512	249297
1997	1974	206295	196994	111571	101406	106217	179425	317506	278298	219850	279933	337016	395318	476730	324601
	1972	216367	200000	112751	110299	115858	138305	199049	237411	316173	312428	235695	407335	478861	285484
	1956	196166	150920	102457	116557	144555	195746	261034	165218	209596	259452	370997	435026	417652	249904
	average	206276	182638	108926	109421	122210	171159	259196	226976	248540	283938	314569	412560	457748	286663
1998	1962	178400	134937	95007	101990	113604	113432	169643	117810	109436	250471	271037	247015	235271	197428
	1949	140588	111361	87627	110087	117654	127870	150126	142907	199198	176289	277735	345861	259697	150246
	1934	137656	115761	95595	120423	161390	231081	300465	240584	179966	280961	293083	272537	162627	186034
	average	152215	120686	92743	110833	130883	157461	206745	167100	162867	235907	280618	288471	219198	177903
1999	1965	200000	164725	106926	125344	124411	200265	271505	235434	194165	206007	305909	332524	318397	212064
	1954	230840	201370	161930	106653	121438	146643	172181	192261	152800	199639	218224	318359	371064	265034
	1943	196894	146531	98172	103241	112102	136356	187710	173700	175869	310670	314293	323534	290350	241787
	average	209245	170875	122343	111746	119317	161088	210465	200465	174278	238772	279475	324806	326604	239628
2000	1936	156408	120389	93816	98629	117341	119307	107927	96316	113364	135082	214737	322656	213045	159180
	1934	137656	115761	95595	120423	161390	231081	300465	240584	179966	280961	293083	272537	162627	186034
	1970	137207	110882	93520	102749	118040	126701	181432	167544	119456	118110	184704	249007	318122	164849
	average	143757	115677	94310	107267	132257	159030	196608	168148	137595	178051	230841	281400	231265	170021

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Table 5. McNary period average discharge under the Proposed Action (continued)

BiOp Study year	HYDSIM Surrogate years	Total discharge in cfs													
		AUG1	AUG2	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR1	APR2	MAY	JUN	JUL
2001	1977	135013	109155	92069	111072	116755	122666	145161	95506	89079	101816	103007	144005	144478	115684
	1931	133078	115585	93974	102316	117676	119743	95908	92882	99902	141025	110278	136763	153920	139757
	1944	125971	110238	92701	103132	116639	124285	143989	97883	98711	112319	112098	126129	158111	132600
	average	131354	111659	92915	105507	117023	122231	128353	95424	95897	118387	108461	135632	152170	129347
2002	1955	202185	182254	103280	114724	139050	145546	131039	103718	97756	121380	143066	199780	380670	299954
	1947	175642	118101	99201	102829	117787	186072	203585	180963	185649	161451	217658	299698	249229	212518
	1960	184801	114210	95843	171202	171226	185475	193021	136525	147133	293370	261983	248343	270717	211992
	average	187543	138188	99441	129585	142688	172364	175882	140402	143513	192067	207569	249274	300205	241488
2003	1939	170907	122390	93900	103985	116676	120153	147432	99533	118632	141716	163143	231857	168165	158442
	1945	139364	118567	88539	97648	116950	119419	98447	108147	104745	116155	119957	206197	246278	176517
	1940	134684	111012	93196	103671	117690	115317	140558	113751	160483	161701	194842	209855	191642	148324
	average	148318	117323	91878	101768	117105	118296	128812	107144	127953	139857	159314	215970	202028	161094

McNary Average Period Discharge in cfs

BiOp Study year	Spring Rounded April 10-June 30	Spring April 10-June 30	Summer July 1 - Sept. 30	Summer Rounded July 1 - Sept 30
1994	162020	162015	124269	124270
1995	244380	244385	139054	139050
1996	315890	315894	190117	190120
1997	401760	401755	197508	197510
1998	257840	257845	135994	135990
1999	310880	310876	184472	184470
2000	246250	246247	131599	131600
2001	155530	155529	114718	114720
2002	256090	256092	168408	168410
2003	194940	194936	128828	128830
Avg	254560			151500

Table 6. Bonneville chum spawning/incubation period average discharge under the Proposed Action
 Data derived from BPA HYDROSIM Model run: FRIII_03Biop2004.XLS dated 10-21-04

		Total discharge in cfs													
BiOp Study year	HYDSIM Surrogate year	AUG1	AUG2	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR1	APR2	MAY	JUN	JUL
1994	1937	152683	117585	98054	105975	125000	125000	105815	106272	119186	129214	157838	153753	192457	171787
	1940	143556	120274	99392	108737	125000	126035	148665	132437	178663	185327	223844	224971	204818	157590
	1930	158232	124102	97809	105282	125000	125000	100338	138139	118788	133878	145395	141226	178768	159693
	average	151490	120654	98418	106665	125000	125345	118273	125616	138879	149473	175692	173317	192014	163023
1995	1934	211009	198237	115717	127386	172018	276905	343131	263659	204688	302095	328095	288497	177402	196124
	1962	159129	137906	99237	107256	125000	131188	185518	133455	127592	269595	295933	260731	253928	206913
	1936	210158	136248	106414	104025	125000	125000	121409	103967	128294	143066	252586	343536	230650	169362
	average	193432	157464	107123	112889	140673	177698	216686	167027	153525	238252	292205	297588	220660	190800
1996	1954	200522	155217	109484	113288	131339	164066	188012	214713	171611	215007	243719	329924	385889	275717
	1950	149632	118328	95281	108444	125000	131828	177792	221243	255280	252951	285644	306185	438196	285217
	1965	206162	181333	120732	129659	133958	244487	299198	266286	209518	215827	329602	344627	330560	222462
	average	185439	151626	108499	117130	130099	180127	221667	234081	212136	227928	286322	326912	384882	261132
1997	1974	139645	108000	90221	107417	125854	211037	352254	297100	239500	297562	357715	403668	475051	329996
	1972	203583	187703	115235	113662	128318	153314	225843	264579	351090	323688	248689	407143	473603	285170
	1956	215391	190479	112782	125732	162260	226680	293304	181924	232151	281613	403139	461906	441333	262456
	average	186206	162061	106079	115604	138811	197010	290467	247868	274247	300954	336514	424239	463329	292541
1998	1962	159129	137906	99237	107256	125000	131188	185518	133455	127592	269595	295933	260731	253928	206913
	1949	208483	199780	120632	115462	128234	140180	157444	161072	223656	192600	310828	370904	277303	160648
	1934	211009	198237	115717	127386	172018	276905	343131	263659	204688	302095	328095	288497	177402	196124
	average	192874	178641	111862	116701	141751	182758	228698	186062	185312	254763	311619	306711	236211	187895
1999	1965	206162	181333	120732	129659	133958	244487	299198	266286	209518	215827	329602	344627	330560	222462
	1954	200522	155217	109484	113288	131339	164066	188012	214713	171611	215007	243719	329924	385889	275717
	1943	204658	152216	107144	108362	125000	154053	205324	194215	196259	338460	359909	342447	311642	255657
	average	203781	162922	112453	117103	130099	187535	230845	225071	192463	256431	311077	338999	342697	251279
2000	1936	210158	136248	106414	104025	125000	125000	121409	103967	128294	143066	252586	343536	230650	169362
	1934	211009	198237	115717	127386	172018	276905	343131	263659	204688	302095	328095	288497	177402	196124
	1970	175210	113822	99655	107328	125000	136630	215404	190360	138130	128517	200982	257677	323868	165879
	average	198792	149436	107262	112913	140673	179512	226648	185995	157037	191226	260554	296570	243973	177122

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Table 6. Bonneville chum spawning/incubation period average discharge under the Proposed Action (continued)
Total discharge in cfs

BiOp Study year	HYDSIM Surrogate year	AUG1	AUG2	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR1	APR2	MAY	JUN	JUL
2001	1977	259404	237039	174682	117313	125000	132440	154399	101764	96735	110944	117329	150101	151588	119669
	1931	158232	121958	98952	107459	125000	125000	101859	100027	111584	158978	131125	150766	167249	150474
	1944	207482	153267	105687	108907	125000	132089	149977	106712	107143	123217	128931	136345	170684	141276
	average	208373	170755	126440	111226	125000	129843	135412	102834	105154	131046	125795	145737	163174	137140
2002	1955	242992	209008	169853	121207	149076	156175	141675	114614	106939	133855	161541	214690	394102	316045
	1947	205310	137232	112536	107891	129141	212306	218160	200985	204070	176225	241709	316586	264669	222199
	1960	209290	141553	158726	180053	180487	198539	201241	157160	165019	315235	288238	260286	283799	221411
	average	219197	162598	147038	136384	152901	189007	187025	157586	158676	208438	230496	263854	314190	253218
2003	1939	158932	119582	109057	109411	125000	128745	156516	109764	134078	157620	185702	246687	181046	167989
	1945	133452	117187	99667	102542	125000	125000	108720	122052	116585	126921	138137	222426	262075	185948
	1940	179766	128593	101306	108737	125000	126035	148665	132437	183879	179267	219124	224971	204818	157590
	average	157383	121787	103343	106897	125000	126593	137967	121418	144847	154603	180988	231361	215980	170509

Bonneville Average Period Discharge in cfs (Chum spawning/rearing Nov 1 - Apr 15)

BiOp Study year	Chum Flows	Rounded Chum Flows
1994	128857	128860
1995	177445	177450
1996	198456	198460
1997	236340	236340
1998	191467	191470
1999	198720	198720
2000	179291	179290
2001	120950	120950
2002	172903	172900
2003	133496	133500

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Table 7. Lower Granite Reference Operation.

Data from: BPA HYDSIM Study 03FSH05D9 Dated 08-10-04

BiOp Study Year	HYDSIM Surrogate Year	Total Discharge in cfs													
		AUG1	AUG2	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR1	APR2	MAY	JUN	JUL
1994	1934	26668	25735	24394	22178	22599	29767	48949	37545	56097	83648	101309	64653	29314	29909
	1973	31155	20937	25567	30092	27896	33896	35637	30135	34522	37319	54739	68286	50469	37616
	1931	26168	17129	20567	22291	16243	12259	20501	21102	29654	53203	54202	57965	30745	28945
	average	27997	21267	23509	24854	22246	25307	35029	29594	40091	58057	70083	63635	36843	32157
	Add irrig. depletions	5	5	4	4	2	0	1	3	14	40	40	27	17	3
	New avg	28002	21272	23513	24858	22248	25307	35030	29597	40105	58097	70123	63662	36860	32160
1995	1946	34961	32821	35424	27169	21508	33785	36617	34156	60565	85216	123012	119112	81585	46186
	1933	33325	31726	32538	21976	20503	17828	23036	20716	31510	44835	75212	68059	154323	48359
	1959	36171	34655	40000	25583	26835	35379	41148	45218	46761	78029	74695	83574	122496	49317
	average	34819	33067	35987	24909	22949	28997	33600	33363	46279	69360	90973	90248	119468	47954
	Add irrig. depletions	5	5	4	4	2	0	1	3	14	40	40	27	17	3
	New avg	34824	33072	35991	24913	22951	28997	33601	33366	46293	69400	91013	90275	119485	47957
1996	1975	43481	43975	40000	27646	24734	27734	33020	35746	53736	67694	86007	105525	175741	94315
	1976	43200	41107	40000	34169	36876	54092	50813	47682	62207	107046	110024	160387	126511	59181
	1957	35882	33506	33277	27053	22600	34568	29528	44103	65991	85000	91951	168424	129450	48098
	average	40854	39529	37759	29623	28070	38798	37787	42510	60645	86580	95994	144779	143901	67198
	Add irrig. depletions	5	5	4	4	2	0	1	3	14	40	40	27	17	3
	New avg	40859	39534	37763	29627	28072	38798	37788	42513	60659	86620	96034	144806	143918	67201
1997	1974	42837	38942	40000	27684	35033	45550	67563	66100	86289	98802	123596	144488	223515	73468
	1971	42698	37716	40000	31133	31557	39291	61012	82719	72999	94024	114001	178867	181445	72014
	1943	42046	36398	40000	23521	20001	30741	42658	51851	66535	131357	149909	130926	143886	81266
	average	42527	37685	40000	27446	28864	38527	57078	66890	75274	108061	129169	151427	182949	75583
	Add irrig. depletions	5	5	4	4	2	0	1	3	14	40	40	27	17	3
	New avg	42532	37690	40004	27450	28866	38527	57079	66893	75288	108101	129209	151454	182966	75586

Table 7. Lower Granite Reference Operation. (continued)

BiOp Study Year	HYDSIM Surrogate Year	Total discharge in cfs													
		AUG1	AUG2	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR1	APR2	MAY	JUN	JUL
1998	1951	38670	35191	33056	33096	38541	42412	42775	69146	64913	93883	115000	117781	95539	55783
	1949	32902	31654	30603	25324	20348	23123	28128	38361	64169	84518	111152	154611	83159	41456
	1953	38886	35422	39810	23687	16923	20759	44760	46038	41048	54409	84604	84567	145608	61496
	average	36819	34089	34490	27369	25271	28765	38554	51182	56710	77603	103585	118986	108102	52912
Add irrig. depletions		5	5	4	4	2	0	1	3	14	40	40	27	17	3
	New avg	36824	34094	34494	27373	25273	28765	38555	51185	56724	77643	103625	119013	108119	52915
1999	1950	41747	36032	40000	25379	20813	25363	32155	44439	65294	91261	100154	97464	157504	68021
	1964	40132	36352	40000	24872	19891	19576	27076	27874	35541	64754	77021	95661	173290	60000
	1969	35788	39094	38114	32263	31113	33266	52348	42110	60915	100804	115000	153012	86360	46769
	average	39222	37159	39371	27505	23939	26068	37193	38141	53917	85606	97392	115379	139051	58263
Add irrig. depletions		5	5	4	4	2	0	1	3	14	40	40	27	17	3
	New avg	39227	37164	39375	27509	23941	26068	37194	38144	53931	85646	97432	115406	139068	58266
2000	1942	33973	32033	28917	27169	25738	38751	28593	32049	32602	72173	101242	81003	85205	51204
	1961	29604	29006	30191	23396	20291	18767	22146	41506	38292	46327	60168	89795	98769	36935
	1940	28811	27272	27896	21558	16022	17142	24798	35760	50576	71963	89119	86211	49669	34941
	average	30796	29437	29001	24041	20684	24887	25179	36438	40490	63488	83510	85670	77881	41027
Add irrig. depletions		5	5	4	4	2	0	1	3	14	40	40	27	17	3
	New avg	30801	29442	29005	24045	20686	24887	25180	36441	40504	63528	83550	85697	77898	41030
2001	1973	31155	20937	25567	30092	27896	33896	35637	30135	34522	37319	54739	68286	50469	37616
	1931	26168	17129	20567	22291	16243	12259	20501	21102	29654	53203	54202	57965	30745	28945
	1977	15207	15803	23656	30106	19313	26148	25208	26371	22738	28841	50887	37776	33752	31363
	average	24177	17956	23263	27496	21151	24101	27115	25869	28971	39788	53276	54676	38322	32641
Add irrig. depletions		5	5	4	4	2	0	1	3	14	40	40	27	17	3
	New avg	24182	17961	23267	27500	21153	24101	27116	25872	28985	39828	53316	54703	38339	32644

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Table 7. Lower Granite Reference Operation (continued)

BiOp Study year	HYDSIM Surrogate year	Total discharge in cfs													
		AUG1	AUG2	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR1	APR2	MAY	JUN	JUL
2002	1955	36177	32452	35018	23513	18153	21182	25900	26729	23963	44792	59897	77972	116948	59666
	1960	34405	32377	31973	41883	30487	26748	29974	36339	54709	86056	79070	90605	101551	42559
	1963	36655	34398	33064	34317	26331	38426	29296	57312	38273	49214	64394	91513	104620	51721
	average	35746	33076	33352	33238	24990	28785	28390	40127	38982	60021	67787	86697	107706	51315
Add irrig. depletions		5	5	4	4	2	0	1	3	14	40	40	27	17	3
	New avg	35751	33081	33356	33242	24992	28785	28391	40130	38996	60061	67827	86724	107723	51318
2003	1961	29604	29006	30191	23396	20291	18767	22146	41506	38292	46327	60168	89795	98769	36935
	1940	28811	27272	27896	21558	16022	17142	24798	35760	50576	71963	89119	86211	49669	34941
	1968	35788	39094	38114	27174	25793	30681	32091	50580	42067	39897	49480	65281	95783	43754
	average	31401	31791	32067	24043	20702	22197	26345	42615	43645	52729	66256	80429	81407	38543
Add irrig. depletions		5	5	4	4	2	0	1	3	14	40	40	27	17	3
	New avg	31406	31796	32071	24047	20704	22197	26346	42618	43659	52769	66296	80456	81424	38546
Average Period Discharge in cfs		Spring	Summer												
		BiOp	April 3	June 21											
		Study	-June	- Sept											
		Year	20	30											
		1994	57190	27760											
		1995	94380	47180											
		1996	125750	57850											
		1997	148070	64840											
		1998	106530	47590											
		1999	113090	54520											
		2000	79670	37790											
		2001	47850	26900											
		2002	84060	46410											
		2003	73460	38740											

Table 8. McNary Period Average Discharge under Reference Operation

Data Derived from BPA HYDROSIM Model Run: 03FSH05D9 Dated 8-10-04

BiOp Study	HYDSIM Surrogate	Year	Total Discharge in cfs												
			AUG1	AUG2	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR1	APR2	MAY	JUN
1994	1937	200000	179560	124420	101108	116865	107767	104109	82997	84076	82651	146598	130553	166342	210000
	1940	200000	169651	114486	109142	118665	103422	121894	101530	106605	205424	244691	182532	181194	210000
	1930	200000	169862	121736	94805	115197	110294	100781	94879	97493	99496	147614	116496	150923	210000
	average	200000	173024	120214	101685	116909	107161	108928	93135	96058	129190	179634	143194	166153	210000
Add irrig. depletions		263	263	122	68	2	0	1	3	14	52	52	-199	591	303
New avg		200263	173287	120336	101753	116911	107161	108929	93138	96072	129242	179686	142995	166744	210303
1995	1934	200000	200000	125000	119731	165865	190780	266193	229444	189663	293331	332450	279245	193673	210000
	1962	200000	200000	125000	108438	118604	112244	114125	114355	111845	222635	263551	207641	264686	210000
	1936	200000	197014	125000	121298	122341	124307	116518	111855	110437	121821	270638	285770	194519	210000
	average	200000	199005	125000	116489	135603	142444	165612	151885	137315	212596	288880	257552	217626	210000
Add irrig. depletions		263	263	122	68	2	0	1	3	14	52	52	-199	591	303
New avg		200263	199268	125122	116557	135605	142444	165613	151888	137329	212648	288932	257353	218217	210303
1996	1954	267431	211011	157533	120059	120099	112577	114169	149170	170677	195700	237963	293606	387201	323804
	1950	203852	200000	125000	107334	119206	116851	118482	99118	208858	240611	267832	242202	444823	297322
	1965	200000	200000	125000	122378	120454	160955	237703	210009	203631	237609	356280	325217	347360	244512
	average	223761	203670	135844	116590	119920	130128	156785	152766	194389	224640	287358	287008	393128	288546
Add irrig. depletions		263	263	122	68	2	0	1	3	14	52	52	-199	591	303
New avg		224024	203933	135966	116658	119922	130128	156786	152769	194403	224692	287410	286809	393719	288849

Table 8. McNary Period Average Discharge under Reference Operation (continued)

BiOp Study Year	HYDSIM Surrogate														
	Year	AUG1	AUG2	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR1	APR2	MAY	JUN	JUL
1997	1974	238651	200000	125000	111422	110363	98387	244995	226722	204236	290959	346753	363720	557818	355316
	1972	244636	200000	125000	123331	117541	114991	143228	209831	315857	300179	267243	385030	549780	319718
	1956	200000	200000	125000	117518	112295	162955	230790	153067	214316	267845	360472	476143	451014	280750
	average	227762	200000	125000	117424	113400	125444	206338	196540	244803	286328	324823	408298	519537	318595
Add irrig. depletions		263	263	122	68	2	0	1	3	14	52	52	-199	591	303
New avg		228025	200263	125122	117492	113402	125444	206339	196543	244817	286380	324875	408099	520128	318898
1998	1962	200000	200000	125000	108438	118604	112244	114125	114355	111845	222635	263551	207641	264686	210000
	1949	200000	179473	125000	121318	119420	117690	90254	111834	214862	201762	298135	392037	244764	210000
	1934	200000	200000	125000	119731	165865	190780	266193	229444	189663	293331	332450	279245	193673	210000
	average	200000	193158	125000	116496	134630	140238	156857	151878	172123	239243	298045	292974	234374	210000
Add irrig. depletions		263	263	122	68	2	0	1	3	14	52	52	-199	591	303
New avg		200263	193421	125122	116564	134632	140238	156858	151881	172137	239295	298097	292775	234965	210303
1999	1965	200000	200000	125000	122378	120454	160955	237703	210009	203631	237609	356280	325217	347360	244512
	1954	267431	211011	157533	120059	120099	112577	114169	149170	170677	195700	237963	293606	387201	323804
	1943	200000	200000	125000	121572	117102	112304	95892	147693	188631	290194	368922	290050	317335	265224
	average	222477	203670	135844	121336	119218	128612	149255	168957	187646	241168	321055	302958	350632	277847
Add irrig. depletions		263	263	122	68	2	0	1	3	14	52	52	-199	591	303
New avg		222740	203933	135966	121404	119220	128612	149256	168960	187660	241220	321107	302759	351223	278150
2000	1936	200000	197014	125000	121298	122341	124307	116518	111855	110437	121821	270638	285770	194519	210000
	1934	200000	200000	125000	119731	165865	190780	266193	229444	189663	293331	332450	279245	193673	210000
	1970	200000	175699	125000	114155	123040	120070	96028	107184	130616	196571	219737	239206	315064	210000
	average	200000	190904	125000	118395	137082	145052	159580	149494	143572	203908	274275	268074	234419	210000
Add irrig. depletions		263	263	122	68	2	0	1	3	14	52	52	-199	591	303
New avg		200263	191167	125122	118463	137084	145052	159581	149497	143586	203960	274327	267875	235010	210303

Table 8. McNary Period Average Discharge under Reference Operation (continued)

BiOp Study Year	HYDSIM Surrogate Year	AUG1	AUG2	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR1	APR2	MAY	JUN	JUL
2001	1977	168343	162905	125000	120453	121755	120226	120761	123742	119665	99412	150599	108273	137350	208998
	1931	190852	164573	111774	86473	106960	100464	98496	77627	92889	119526	151772	103618	133130	210000
	1944	164517	155516	121518	120919	121639	122196	124012	115326	118970	97998	145827	113191	150328	209272
	average	174571	160998	119431	109282	116785	114295	114423	105565	110508	105645	149399	108361	140269	209423
Add irrig. depletions		263	263	122	68	2	0	1	3	14	52	52	-199	591	303
	New avg	174834	161261	119553	109350	116787	114295	114424	105568	110522	105697	149451	108162	140860	209726
2002	1955	228377	200000	125000	120211	132130	121161	119363	119104	120817	132409	168301	162754	402778	324763
	1947	200000	200000	125000	121631	118646	103766	149702	150814	196696	166496	250675	313477	257840	239888
	1960	200000	200000	125000	165144	186873	153914	159455	132336	129637	269688	280015	274089	308340	252979
	average	209459	200000	125000	135662	145883	126280	142840	134085	149050	189531	232997	250107	322986	272543
Add irrig. depletions		263	263	122	68	2	0	1	3	14	52	52	-199	591	303
	New avg	209722	200263	125122	135730	145885	126280	142841	134088	149064	189583	233049	249908	323577	272846
2003	1939	200000	194243	125000	121267	121676	121408	120916	116395	110538	151312	198078	183298	139593	210000
	1945	200000	191589	125000	87199	112723	96878	97628	99054	95119	89781	138300	184056	227615	210000
	1940	200000	169651	114486	109142	118665	103422	121894	101530	106605	205424	244691	182532	181194	210000
	average	200000	185161	121495	105869	117688	107236	113479	105660	104087	148839	193690	183295	182801	210000
Add irrig. depletions		263	263	122	68	2	0	1	3	14	52	52	-199	591	303
	New avg	200263	185424	121617	105937	117690	107236	113480	105663	104101	148891	193742	183096	183392	210303

Table 8. McNary Period Average Discharge under Reference Operation (continued)

Average Period Discharge in cfs

Surrogate Year	Spring April 10- June 30	Summer July 1 - Sept 30
1994	157390	172890
1995	245540	178970
1996	321490	213660
1997	424950	220260
1998	268690	177950
1999	319340	209840
2000	252350	177560
2001	127500	166200
2002	269360	201760
2003	182650	175420

Biological Opinion on Remand

Table 9. Bonneville Chum Spawning/incubation Period Average Discharge under Reference Operation.

Data Derived from BPA HYDROSIM Model Run: 03FSH05D91 Dated 8-10-04

Using Same Surrogate Years Used for McNary.

BiOp Study Year	HYDSIM Surrogate Year	Total Discharge in cfs													
		AUG1	AUG2	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR1	APR2	MAY	JUN	JUL
1994	1937	208720	204465	132857	99586	123808	113497	106934	89685	96345	113121	169253	146509	185475	221124
	1940	208859	200446	132406	107515	125975	114141	130000	120216	130000	240970	264826	197646	194372	219266
	1930	207581	173299	132257	93192	122134	118620	104391	112078	108396	130780	167824	127888	162791	219906
	average	208387	192737	132507	100098	123972	115419	113775	107326	111580	161624	200634	157348	180879	220099
Add irrig. depletions		165	165	-77	-259	0	217	345	415	371	239	239	-212	447	311
	New avg	208552	192902	132430	99839	123972	115636	114120	107741	111951	161863	200873	157136	181326	220410
1995	1934	268461	208257	133327	120000	176493	236603	308859	252519	214385	332442	363318	295203	208449	220090
	1962	208472	209417	132888	107010	130000	130000	130000	130000	130000	259739	284301	221356	283343	219485
	1936	210158	206849	132796	120000	130000	130000	130000	119506	125368	147785	304341	306650	212124	220182
	average	229030	208174	133004	115670	145498	165534	189620	167342	156584	246655	317320	274403	234639	219919
Add irrig. depletions		165	165	-77	-259	0	217	345	415	371	239	239	-212	447	311
	New avg	229195	208339	132927	115411	145498	165751	189965	167757	156955	246894	317559	274191	235086	220230
1996	1954	206925	206786	133402	120000	130000	130000	130000	171622	189487	229047	259311	305171	402026	325787
	1950	209044	186440	132654	106381	130000	130000	130000	119219	236586	278388	292093	261194	469943	303047
	1965	235691	206988	131263	120000	130000	205177	265396	240861	218984	265408	375826	337320	359524	254910
	average	217220	200071	132440	115460	130000	155059	175132	177234	215019	257614	309077	301228	410498	294581
Add irrig. depletions		165	165	-77	-259	0	217	345	415	371	239	239	-212	447	311
	New avg	217385	200236	132363	115201	130000	155276	175477	177649	215390	257853	309316	301016	410945	294892

Table 9. Bonneville Chum Spawning/incubation Period Average Discharge under Reference Operation (continued)

BiOp Study	HYDSIM Surrogate	Year	AUG1	AUG2	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR1	APR2	MAY	JUN	JUL
1997	1974	202790	160827	130000	110739	130000	130000	279744	245525	223886	326568	363306	372071	556139	352011	
	1972	209294	202642	130070	120000	130000	130000	170022	236999	350774	329419	276090	384838	544523	310703	
	1956	259563	208225	134502	120000	130000	193889	263061	169773	236872	307986	388467	503023	474694	293302	
	average	223882	190565	131524	116913	130000	151296	237609	217432	270511	321324	342621	419977	525119	318672	
	Add irrig. depletions	165	165	-77	-259	0	217	345	415	371	239	239	-212	447	311	
1998	New avg	224047	190730	131447	116654	130000	151513	237954	217847	270882	321563	342860	419765	525566	318983	
	1962	208472	209417	132888	107010	130000	130000	130000	130000	130000	259739	284301	221356	283343	219485	
	1949	208483	206880	131459	120000	130000	130000	97572	130000	239319	236053	327082	417080	262370	220402	
	1934	268461	208257	133327	120000	176493	236603	308859	252519	214385	332442	363318	295203	208449	220090	
	average	228472	208185	132558	115670	145498	165534	178810	170840	194568	276078	324900	311213	251387	219992	
Add irrig. depletions	165	165	-77	-259	0	217	345	415	371	239	239	-212	447	311		
	New avg	228637	208350	132481	115411	145498	165751	179155	171255	194939	276317	325139	311001	251834	220303	
1999	1965	235691	206988	131263	120000	130000	205177	265396	240861	218984	265408	375826	337320	359524	254910	
	1954	206925	206786	133402	120000	130000	130000	130000	171622	189487	229047	259311	305171	402026	325787	
	1943	208814	205960	132026	120000	130000	130000	113507	168208	209021	335964	410391	308963	338627	279094	
	average	217143	206578	132230	120000	130000	155059	169634	193564	205831	276806	348509	317151	366726	286597	
	Add irrig. depletions	165	165	-77	-259	0	217	345	415	371	239	239	-212	447	311	
New avg	217308	206743	132153	119741	130000	155276	169979	193979	206202	277045	348748	316939	367173	286908		
	1936	210158	206849	132796	120000	130000	130000	130000	119506	125368	147785	304341	306650	212124	220182	
2000	1934	268461	208257	133327	120000	176493	236603	308859	252519	214385	332442	363318	295203	208449	220090	
	1970	205841	205323	130137	112041	130000	130000	130000	130000	149290	224958	231869	247877	320810	211030	
	average	228153	206810	132087	117347	145498	165534	189620	167342	163014	235062	299843	283243	247128	217101	
	Add irrig. depletions	165	165	-77	-259	0	217	345	415	371	239	239	-212	447	311	
New avg	228318	206975	132010	117088	145498	165751	189965	167757	163385	235301	300082	283031	247575	217412		

Table 9. Bonneville Chum Spawning/incubation Period Average Discharge under Reference Operation (continued)

BiOp Study Year	HYDSIM Surrogate Year	AUG1	AUG2	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR1	APR2	MAY	JUN	JUL
2001	1977	287394	246272	175955	120000	130000	130000	130000	130000	127321	126521	160774	114370	144458	212982
	1931	207769	176573	129098	84922	114284	105722	104446	84772	104571	155458	168472	117620	146459	220718
	1944	210588	206736	132515	120000	130000	130000	130000	124155	127403	126876	158514	123407	162901	217949
	average	235250	209860	145856	108307	124761	121907	121482	112976	119765	136285	162587	118466	151273	217216
Add irrig. depletions		165	165	-77	-259	0	217	345	415	371	239	239	-212	447	311
	New avg	235415	210025	145779	108048	124761	122124	121827	113391	120136	136524	162826	118254	151720	217527
2002	1955	297563	218649	165455	120000	142156	131791	130000	130000	130000	162861	182633	177664	416209	332154
	1947	209135	206537	131679	120000	130000	130000	164277	170836	215117	199248	270582	330363	273281	249569
	1960	237656	207025	143889	167301	196135	166978	167674	152971	147523	309533	302123	286032	321422	262398
	average	248118	210737	147008	135767	156097	142923	153984	151269	164213	223881	251779	264686	336971	281374
Add irrig. depletions		165	165	-77	-259	0	217	345	415	371	239	239	-212	447	311
	New avg	248283	210902	146931	135508	156097	143140	154329	151684	164584	224120	252018	264474	337418	281685
2003	1939	209940	206892	132702	120000	130000	130000	130000	126627	125985	185194	216493	198128	152474	219547
	1945	171998	162465	128484	85400	120774	102459	107901	112958	106959	118527	152333	200285	243412	219431
	1940	208859	200446	132406	107515	125975	114141	130000	120216	130000	240970	264826	197646	194372	219266
	average	196932	189934	131197	104305	125583	115533	122634	119934	120981	181564	211217	198686	196753	219415
Add irrig. depletions		165	165	-77	-259	0	217	345	415	371	239	239	-212	447	311
	New avg	197097	190099	131120	104046	125583	115750	122979	120349	121352	181803	211456	198474	197200	219726

Table 9. Bonneville Chum Spawning/incubation Period Average Discharge under Reference Operation (continued)

Bonneville Average Period Discharge in cfs

Chum Spawning/rearing Nov 1 - Apr 15

BiOp Study Year	Chum Flows
1994	119017
1995	172641
1996	178743
1997	212614
1998	180964
1999	180495
2000	172764
2001	122002
2002	160334
2003	126668

Table 10. Snake River at Lower Granite Dam flow comparison

These data compare the average seasonal flows at Lower Granite Dam of 3 years with similar runoff volumes to the BiOp study years (1994-2003).

		Proposed Action [2000 biop base case3yr_averages10-21-04]				Reference Operation [Reference ops case3yr_averages08-10-04]				
BiOp Study <u>year</u>	Surrogate Runoff Years	Spring		Summer		BiOp Study <u>year</u>	Spring		Summer	
		April 3-	June 21 –	June 20	Sept 30		April 3-	June 21 -	June 20	Sept 30
		Season	Season	Average	Average		Season	Season	Average	Average
		<u>Flow (cfs)</u>	<u>Flow (cfs)</u>				<u>Flow (cfs)</u>	<u>Flow (cfs)</u>		<u>Flow (cfs)</u>
1994	1934 1973 1931	56030	26620			1994	1934 1973 1931	57190	27760	
1995	1946 1933 1959	93390	43530			1995	1946 1933 1959	94380	47180	
1996	1975 1976 1957	125230	54920			1996	1975 1976 1957	125750	57850	
1997	1974 1971 1943	145730	61620			1997	1974 1971 1943	148070	64840	
1998	1951 1949 1953	105170	44710			1998	1951 1949 1953	106530	47590	
1999	1950 1964 1969	112440	49090			1999	1950 1964 1969	113090	54520	
2000	1942 1961 1940	80020	35150			2000	1942 1961 1940	79670	37790	
2001	1973 1931 1977	53990	26910			2001	1973 1931 1977	47850	26900	
2002	1955 1960 1963	84800	42880			2002	1955 1960 1963	84060	46410	
2003	1961 1940 1968	73320	35700			2003	1961 1940 1968	73460	38740	
Average		93030	42100			Average		93000	44960	

Table 10. Snake River at Lower Granite Dam flow comparison (continued)

BiOp Study <u>year</u>	Flow Comparison (Proposed Action minus Reference Operation)			Relative Difference		
			Spring	Summer	Spring	Summer
	Surrogate Runoff Years		April 3-June 20 <u>difference (cfs)</u>	June 21 - Sept 30 <u>difference (cfs)</u>	Relative change to Ref. Op., in %	Relative change to Ref. Op., in %
1994	1934	1973	1931	-1160	-1140	-2.0%
1995	1946	1933	1959	-990	-3650	-1.0%
1996	1975	1976	1957	-520	-2930	-0.4%
1997	1974	1971	1943	-2340	-3220	-1.6%
1998	1951	1949	1953	-1360	-2880	-1.3%
1999	1950	1964	1969	-650	-5430	-0.6%
2000	1942	1961	1940	350	-2640	0.4%
2001	1973	1931	1977	6140	10	12.8%
2002	1955	1960	1963	740	-3530	0.9%
2003	1961	1940	1968	-140	-3040	-0.2%
Average difference			7	-2845	0.0%	-6.3%

Table 11. Columbia River at McNary Dam flow comparison

These data compare the average seasonal flows at McNary Dam of 3 years with similar runoff volumes to the surrogate year (1994-2003).

2000 BiOp Proposed Action
[2000 biop base case3yr_averages10-21-04]

Average flows derived from BPA HYDSIM model study
FRIII_03Biop2004.XLS dated 10-21-04.

BiOp Study <u>year</u>	<u>Surrogate Runoff Years</u>	Spring		Summer	
		April 10-	July 1 -	June 30	Sept 30
		Seasonal	Seasonal	Ave (cfs)	Ave (cfs)
1994	1940 1937 1930	162450	124270		
1995	1962 1934 1936	245220	139050		
1996	1950 1954 1965	316440	190190		
1997	1974 1972 1956	401760	197510		
1998	1949 1962 1934	258680	135990		
1999	1954 1965 1943	311260	184470		
2000	1934 1936 1970	246490	131600		
2001	1931 1944 1977	156400	114720		
2002	1947 1955 1978	256530	168410		
2003	1945 1939 1940	195610	128830		
Average		255080	151500		

Reference Operation
[Reference ops case3yr_averages08-10-04]

Average flows derived from BPA HYDSIM model study
03FSH05D9 dated 8-10-04.

BiOp Study <u>year</u>	<u>Surrogate Runoff Years</u>	Spring		Summer	
		April 10-	July 1 -	June 30	Sept 30
		Seasonal	Seasonal	Ave (cfs)	Ave (cfs)
1994	1940 1937 1930	1940	1937	1930	157390
1995	1962 1934 1936	1962	1934	1936	245540
1996	1950 1954 1965	1950	1954	1965	321490
1997	1974 1972 1956	1974	1972	1956	424950
1998	1949 1962 1934	1949	1962	1934	268690
1999	1954 1965 1943	1954	1965	1943	319340
2000	1934 1936 1970	1934	1936	1970	252350
2001	1931 1944 1977	1931	1944	1977	127500
2002	1947 1955 1978	1947	1955	1978	269360
2003	1945 1939 1940	1945	1939	1940	182650
Average					256926
					189451

Table 12. Columbia River at McNary Dam flow comparison (continued)

Flow Comparison (Proposed Action minus Reference Operation)

Average Period Discharge in cfs

Periods as defined in 2000 FCRPS biop Table 9.6-1

BiOp Study year	Surrogate Runoff Years	April 10-June 30 Difference (cfs)	Summer Difference (cfs)	Relative Difference	
				Spring	Summer
1994	1940	1937	1930	5060	-48620
1995	1962	1934	1936	-320	-39920
1996	1950	1954	1965	-5050	-23470
1997	1974	1972	1956	-23190	-22750
1998	1949	1962	1934	-10010	-41960
1999	1954	1965	1943	-8080	-25370
2000	1934	1936	1970	-5860	-45960
2001	1931	1944	1977	28900	-51480
2002	1947	1955	1978	-12830	-33350
2003	1945	1939	1940	12960	-46590
Average difference		-1842	-37947	-0.7%	-20.0%

Table 12. Columbia River at Bonneville Dam flow comparison.

These data compare the average seasonal flows at McNary Dam of 3 years with similar runoff volumes to the surrogate year (1994-2003).

Proposed Action [2000 BiOp Base Case3yr_Averages 10-21-04]

Average flows derived from BPA HYDSIM model study 03SN6704S1 dated 8-06-04.

BiOp Study year	Surrogate Runoff Years			Fall/Winter November 1 -Apr 15 (cfs)
1994	1940	1937	1930	128715
1995	1962	1934	1936	176758
1996	1950	1954	1965	197848
1997	1974	1972	1956	236340
1998	1949	1962	1934	190778
1999	1954	1965	1943	198376
2000	1934	1936	1970	179092
2001	1931	1944	1977	120950
2002	1947	1955	1978	172696
2003	1945	1939	1940	133233
Average				173479

Reference Operation [Reference ops case3yr_averages08-10-04]

Average flows derived from BPA HYDSIM model study 03FSH05D91 dated 8-10-04. In cfs

Period is Nov1 through April 15

BiOp Study year	Surrogate Runoff Years			Fall/Winter November 1 – Apr 15 (cfs)
1994	1940	1937	1930	119017
1995	1962	1934	1936	172641
1996	1950	1954	1965	178743
1997	1974	1972	1956	212614
1998	1949	1962	1934	180964
1999	1954	1965	1943	180495
2000	1934	1936	1970	172764
2001	1931	1944	1977	122002
2002	1947	1955	1978	160334
2003	1945	1939	1940	126668
Average				162624

Table 12. Columbia River at Bonneville Dam flow comparison (continued)

Flow Comparison (Proposed Action minus Reference Operation)

Average Period Discharge in cfs

Periods as defined in 2000 FCRPS biop Table 9.6-1

<u>BiOp Study year</u>	<u>Surrogate Runoff Years</u>			<u>Fall November 1 to Apr 15 Difference</u>	<u>Fall Relative change to Ref. Op., in %</u>
1994	1940	1937	1930	9698	8.1%
1995	1962	1934	1936	4118	2.4%
1996	1950	1954	1965	19105	10.7%
1997	1974	1972	1956	23725	11.2%
1998	1949	1962	1934	9813	5.4%
1999	1954	1965	1943	17881	9.9%
2000	1934	1936	1970	6329	3.7%
2001	1931	1944	1977	-1052	-0.9%
2002	1947	1955	1978	12361	7.7%
2003	1945	1939	1940	6565	5.2%
Average difference				10854	6.7%